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TERMINAL CONFIGURED VEHICLE ADVANCED
GUIDANCE AND CONTROL SYSTEM MODE SELECT
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LEARNING GUIDE FOR THE TERMINAL CONFIGURED
VEHICLE ADVANCED GUIDANCE AND CONTROL
SYSTEM MODE SELECT PANEL

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INTRODUCTION

Advanced Guidance and Control System (AGCS)

The Advanced Guidance and Control System (AGCS) of the Langley Research Center's Terminal Configured Vehicle (TCV) Aft Flight Deck (AFD) simulator interfaces with the AFD pilot via the AFD Control panels which include those for the navigational computer, EADI, EHSI, and the automatic flight system (ref. 1). The control panel for the automatic flight control system is termed the "AGCS Mode Select Panel" (MSP) and is used to select and engage the following modes of coupled operations:

- o Control Wheel Steering Modes
- o Select/Hold Modes
- o Higher Order Modes

Goals of the Course

The AGCS Course is designed to familiarize pilots with the operation of the AGCS MSP prior to their use of a real-time simulator. The primary goal of the course is to impart a working knowledge of the AGCS MSP and its modes so as to reduce the total simulator time needed by pilots for TCV training (ref. 2).

Prerequisite

Prior to taking this course a pilot should be familiar with the TCV/B737 and the general functions of the AFD.

PLATO
Assisted Learning

PLATO (ref. 3) assisted learning activities provide the primary source of instruction. These PLATO lessons teach the information to be learned in the context of realistic problems. You will be presented with major concepts and have an opportunity to apply the information by answering questions.

As you progress through each PLATO learning activity, you will find the following key functions helpful:

<u>KEY</u>	<u>FUNCTION</u>
NEXT	Progresses you forward through the lesson.
BACK	Returns you to the previous page.
SHIFT-BACK	Returns you to the previous major section.
SHIFT-DATA	Replots the AGCS MSP display if it should be interrupted by an error on the telephone line.

Other functions will be available at different times in the lessons. A description of these key conventions can be seen by pressing NEXT at the title display of each PLATO lesson.

PLATO
Problem Exercise

These exercises are designed to let you evaluate your ability to apply the knowledge learned from a particular activity. They will consist of multiple choice and matching questions.

PLATO

Practical Exercise

This exercise provides practice in using the AGCS MSP. You will be presented with practical problems which may require changes in altitude, calibrated air-speed, flight path angle, and track angle through use of the functions of the AGCS MSP.

Your skill in using the AGCS MSP will be measured according to the number of errors you make. If you make too many errors, you will not be awarded mastery of the lesson.

A Suggested Approach to Completing the Course

You should first familiarize yourself with the contents of the course by quickly scanning the material of this learning guide. When you are ready, sign on to a PLATO terminal.

The lessons may be taken in any order. However, unless you are sure that you need knowledge of the AGCS MSP in an order different from that specified, it is recommended that all lessons and learning activities be completed in the order given.

As you take each PLATO lesson, you may find it helpful to take notes directly in the learning guide to add detail to the summaries.

LESSON 1

AGCS: AN INTRODUCTION

Introduction

The purpose of this lesson is to acquaint you with the Advanced Guidance and Control System (AGCS) Mode Select Panel (MSP). This lesson covers the definition of the nine functional modes of the MSP, the switches and their states (off, preselect, armed, and engaged), and the location of switches, knobs, and digital readouts. See figure 1.

This lesson consists of a PLATO learning activity and an exercise to test your comprehension of the material covered in the learning activity. You can expect to spend about ten minutes in this lesson.

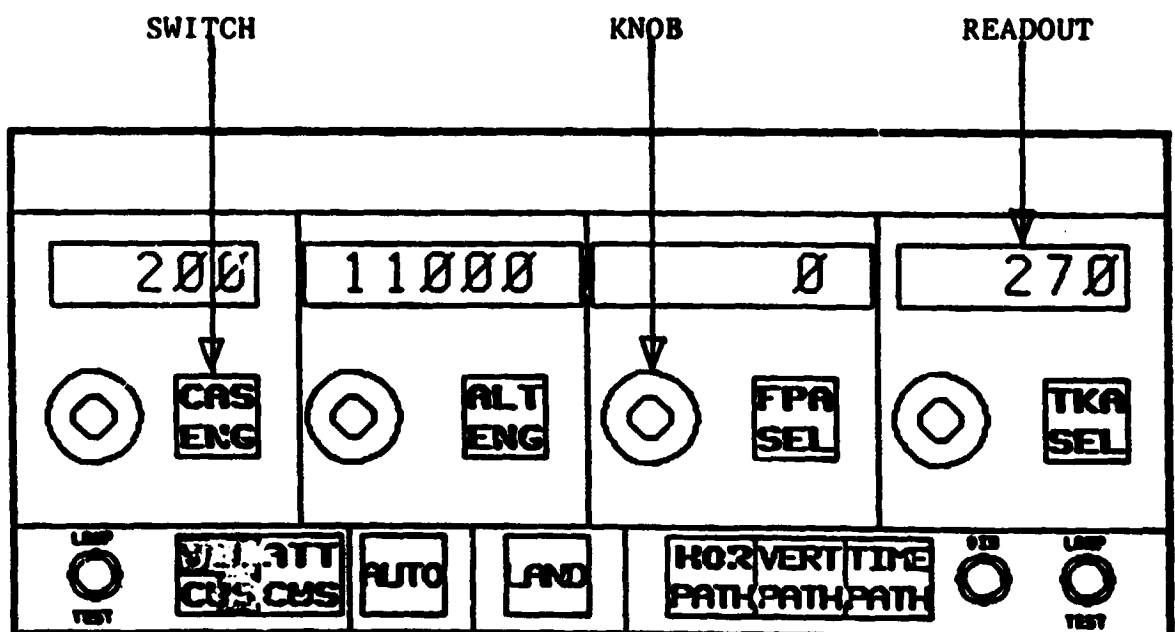


FIGURE 1

Summary

AGCS Advanced Guidance and Control System

I. Purpose

Allows the pilot to select one of three major modes of automatic flight control assistance

II. Major Modes of Assistance

- A. Control Wheel Steering**
- B. Select/hold**
- C. Automatic path (includes autoland)**

III. Each major mode is associated with a distinct subset of switches and lights on the AGCS Mode Select Panel (MSP)

LESSON 2

AGCS LOWER ORDER MODES

(CONTROL WHEEL STEERING AND SELECT/HOLD MODES)

Introduction

The purpose of this lesson is to acquaint you with the AGCS features known as lower order modes. The function and use of the switches, knobs, and digital readouts associated with the following modes are covered:

- Control Wheel Steering (CWS)
- Calibrated Airspeed Engaged (CAS ENG)
- Altitude Engaged (ALT ENG)
- Flight Path Angle Select (FPA SEL)
- Track Angle Select (TKA SEL)

See figure 2.

Completion of this lesson will require about twenty-five to thirty minutes.

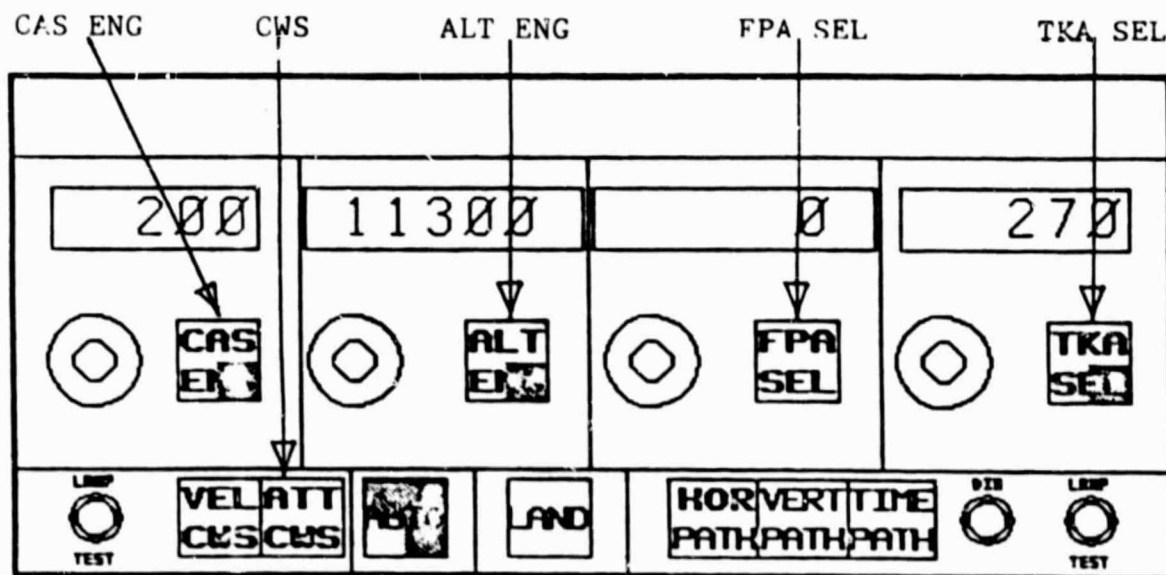


FIGURE 2

AGCS Lower Order Modes

Summary

I. Control Wheel Steering (CWS) Modes

A. Purpose

1. Provides stabilized aircraft response to pilot force inputs via the panel-mounted controllers (PMC)
2. Holds certain variables constant subsequent to the release of pilot force inputs
 - a. pitch and roll attitudes
 - b. track and flight path angles

B. AGCS CWS Modes

1. ATT (attitude) CWS
2. VEL (velocity) CWS

C. ATT CWS (fly attitude of airplane)

1. Selected by the pilot via the ATT CWS switch on the AGCS MSP
2. Roll out-of-detent force ± 3 lbs
3. Roll attitude at force release becomes autopilot hold reference
4. Pitch attitude at force release becomes autopilot hold reference

D. VEL CWS (fly velocity vector of airplane, i.e., inertial flight path angle)

1. Selected by the pilot via the VEL CWS switch on the AGCS MSP
2. Out-of-detent forces same as ATT CWS
3. Bank angle, track angle, and flight path angle are autopilot hold references

II. Select/Hold Modes

A. CAS ENG (Calibrated AirSpeed Engage)

1. Purpose - allows the pilot to control auto-throttle system independent of the navigation computer flight plan
2. Three available states:
 - a. Off - digital readout follows aircraft's current calibrated airspeed
 - b. Preselect (blue) - calibrated airspeed was selected via CAS ENG knob while mode was not engaged
 - c. Engaged (green) - CAS ENG is active and maintaining the calibrated airspeed shown in associated digital readout
3. Components
 - a. CAS ENG Switch
 - b. CAS ENG Knob
 - c. CAS ENG Digital Readout

B. ALT ENG (Altitude Engage)

1. Purpose - allows the pilot to capture and hold a particular altitude automatically
2. Four available states:
 - a. Off - digital readout follows airplane's current altitude to nearest 100 feet.
 - b. Preselect (blue) - An altitude has been entered via the ALT ENG knob but the airplane is not under control of ALT ENG

- c. Armed (amber) - A change in altitude has been preselected that falls outside the range of certain logic conditions permitting automatic altitude intercept
- d. Engaged (green) - ALT ENG is active and maintaining the altitude shown in the associated digital readout

3. Components

- a. ALT ENG Switch
- b. ALT ENG Knob
- c. ALT ENG Digital Readout

4. Dependencies - AUTO engaged

C. FPA SEL (Flight Path Angle Select)

- 1. Purpose - allows the pilot to capture and hold a particular flight path angle and make changes to the flight path angle
- 2. Three available states
 - a. Off - FPA SEL is not active and digital readout tracks the airplane's current flight path angle
 - b. Preselect (blue) - a flight path angle is entered via the FPA SEL knob but the airplane is not under control of FPA SEL
 - c. Engaged (green) - FPA SEL is active and the pilot can change the flight path angle, and thereby steer the airplane, using the FPA SEL Knob

3. Components
 - a. FPA SEL Switch
 - b. FPA SEL Knob
 - c. FPA SEL Digital Readout
4. Dependencies
 - a. AUTO engaged
 - b. AUTO ENG not engaged

D. TKA SEL (Track Angle Select)

1. Purpose - allows the pilot to capture and hold a particular magnetic track angle
2. Three available states
 - a. Off - TKA SEL is not active and the associated digital readout tracks the airplane's current magnetic track angle
 - b. Preselect (blue) - a track angle is entered via the TKA SEL Knob but the airplane is not under TKA SEL control
 - c. Engaged (green) - TKA SEL is active and the pilot can change the airplane's magnetic track angle, and thereby steer the airplane, using the TKA SEL Knob
3. Components
 - a. TKA SEL Switch
 - b. TKA SEL Knob
 - c. TKA SEL Digital Readout
4. Dependencies: AUTO engaged

LESSON 3 ACGS HIGHER ORDER MODES (AUTOPATH MODES)

Introduction

The purpose of this lesson is to acquaint you with the AGCS features known as the higher order modes or autopath/autoland modes. The function and use of the following switches are covered:

- AUTO
- LAND
- HOR PATH
- VERT PATH
- TIME PATH

See figure 3.

Completion of this lesson will require about fifteen minutes.

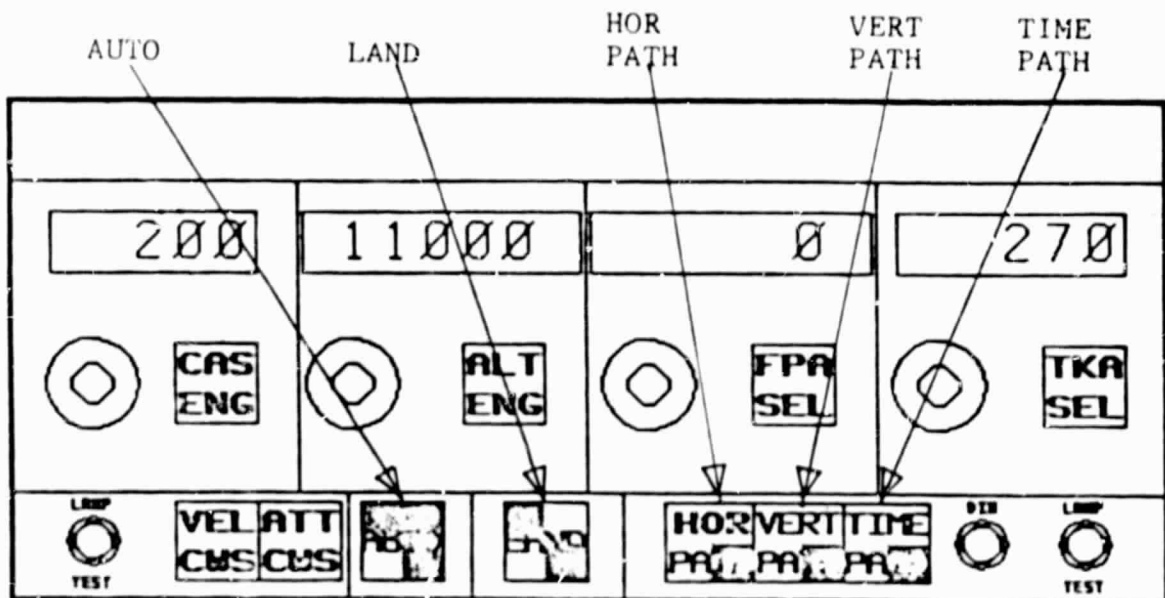


FIGURE 3

Summary

AGCS Higher Order Modes

I. AUTO

- A. Enables all higher order path and select/hold modes EXCEPT autothrottle
- B. Provides access to all of the modes to the right of the auto switch on AGCS MSP
- C. Automatically selects
 - a. FPS SEL
 - b. TKA SEL
- D. Deselecting AUTO reverts system to VEL CWS

II. LAND

- A. Prerequisites
AUTO
- B. Purpose
 - 1. To configure the system for fully automatic ILS/MLS approach and landing
 - 2. Includes
 - a. capture
 - b. tracking
 - c. flare
 - d. decrab
 - e. rollout to a full stop
- C. Switch light
 - 1. Amber from time of select until 10 seconds after glidescope capture

2. Green following 10-second delay after capture

III. HOR PATH

A. Prerequisites

1. AUTO
2. Active 2-D flight plan in navigation computer

B. Purpose

1. Couples the flight-control system to the horizontal guidance path
2. Enables the airplane to follow the horizontal guidance path automatically

C. Deselects TKA SEL mode when HOR PATH selected

D. Switch light is green when engaged

IV. VERT PATH

A. Prerequisites

1. AUTO
2. HOR PATH (armed or engaged)
3. Active 3-D flight plan in navigation computer

B. Purpose

1. Couples the flight control system to the vertical guidance path
2. Enables airplane to follow the vertical guidance profile as defined in the active flight plan

C. Operation

1. Vertical path error less than 150 feet and HOR PATH engaged, VERT PATH engages (green) and FPA SEL disengages
2. Vertical path error greater than 150 feet, VERT PATH goes into armed state (amber), and the pilot selects appropriate vertical-path intercept angle via FPA SEL Knob

V. TIME PATH

A. Prerequisites

1. AUTO
2. HOR PATH
3. VERT PATH (armed or engaged)
4. Active 4-D flight plan in navigation computer

B. Purpose

1. Couples the autothrottle system to the 4-D guidance profile
2. Enables the airplane to automatically capture and track the speed profile as defined in the active flight plan

C. Operation

1. If VERT PATH engaged, TIME PATH engages (green)
2. If VERT PATH armed but not engaged, TIME PATH will be armed (amber)

LESSON 4

AGCS ARRIVAL ROUTE

EXERCISE

Introduction

The purpose of this lesson is to evaluate your ability to use the AGCS MSP in flying the TCV airplane. It is a practical exercise requiring the pilot to configure the AGCS MSP for several different arrival routes. Changes to the aircraft's calibrated airspeed, altitude, flight path angle, and track angle will be required with appropriate changes in the mode states. See figure 4 for a sample question from this exercise.

This exercise will take about fifteen to twenty minutes.

EXAMPLE

Given this arrival route and following problem:

Configure the AGCS panel with the correct SEL/HOLD modes to intercept Byers from Akron 2.

**-NEXT- to continue
Shift-BACK to quit**

CRANES RT 150 N 7000
1.00
1700'
257°
7000'
MULTI-SECTORS
257°
2000'
270°
2500'
BYERS 11000
AKRON 2

Given this arrival route
and following problem:

Configure the AGCS panel with the correct SEL/HOLD modes to intercept Byers from Akron 2.

**-NEXT- to continue
Shift-BACK to quit**



250	14000	0	224
CAS EN	ALT EN	FPA SEL	TKA SEL
VEL ATT CUS CUS	LAND	HOR VERT TIME PATH PATH PATH	LRP TEST

FIGURE 4

REFERENCES

1. National Aeronautics and Space Administration, Langley Research Center: Terminal Configured Vehicle Program, Test Facilities Guide. NASA SP-435, 1980.
2. Houck, Jacob A.; Markos, Athena T.: Development of a Multi-Media Crew-Training Program for the Terminal Configured Vehicle Mission Simulator. Presented at the 1980 Summer Computer Simulation Conference (Seattle, Washington), August, 1980.
3. Paulson, Roger F.: Control Data PLATO System Overview. Control Data Corporation Publication 97406700, 1976.